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# (12) UK Patent Application (19) GB (11) 2 240 614 A (13)

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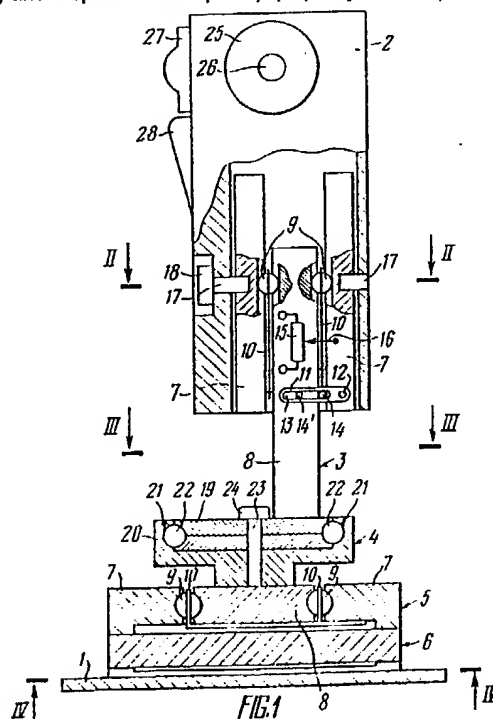
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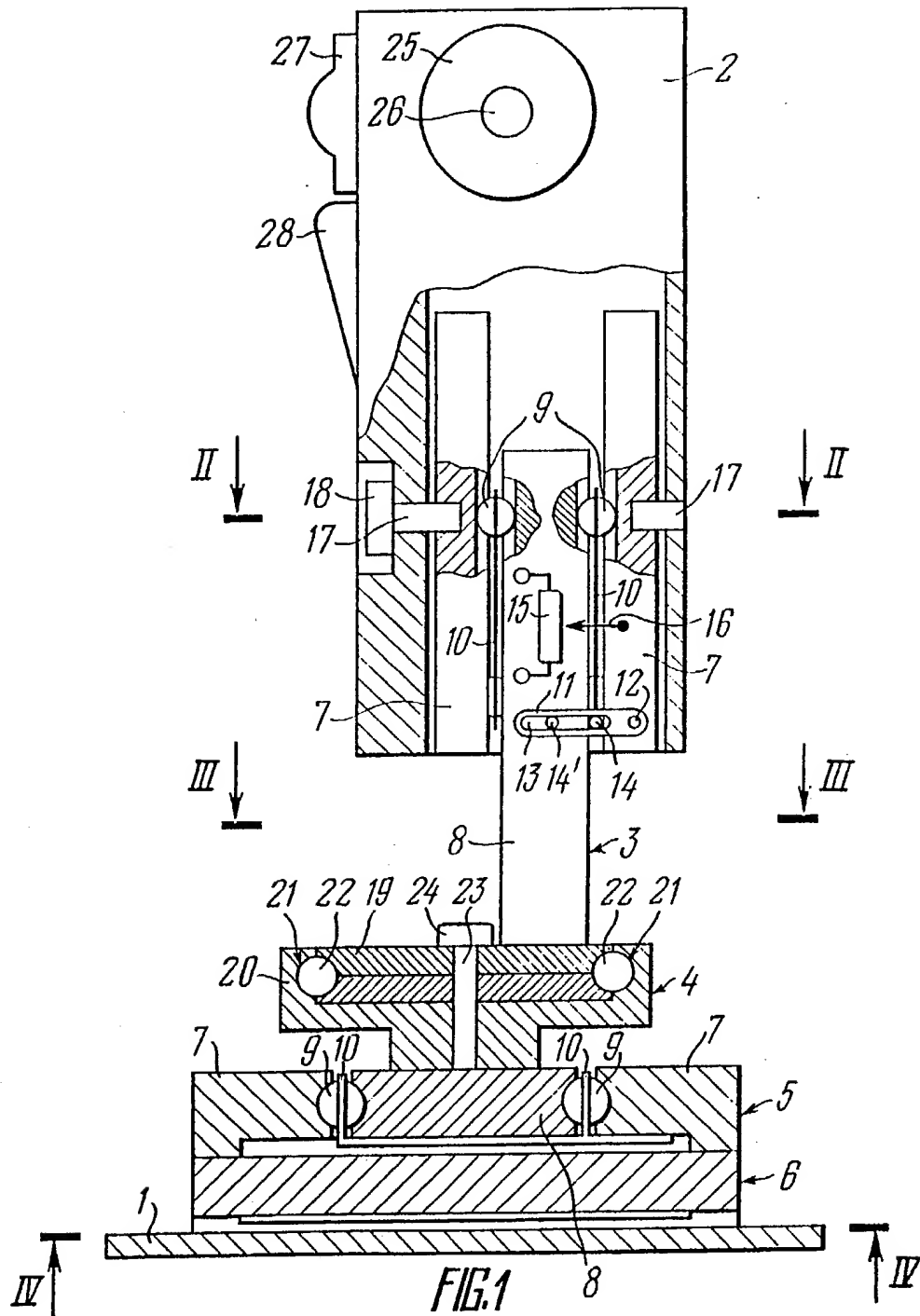
## (54) Modular manual control device for manipulators

(57) The device comprises a base (1), a series of connected modules (4-7), each having a position pickup (eg. 15, 24) and a handle (2). One module is provided for each degree of mobility of the manipulator being controlled; the modular construction enables the control of manipulators with differing degrees of mobility.

In Fig. 1, one rotary movement module (4) and three orthogonal linear movement modules (5, 6, 7) are provided. Each linear module has two parallel guides (7) between which a carriage (8) is supported for movement by balls (9). The position pickup (15) is provided on the carriage (8). The rotary module (4) comprises inner and outer casings (19, 20), relative movement of which is detected by pickup (24). Further rotary pickups (18, 25) may be provided for rotation about axes (17, 26). A close/open switch (27) and a speed control pickup (28) may also be provided.



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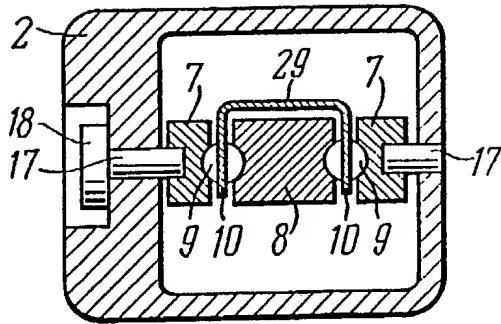


FIG. 2

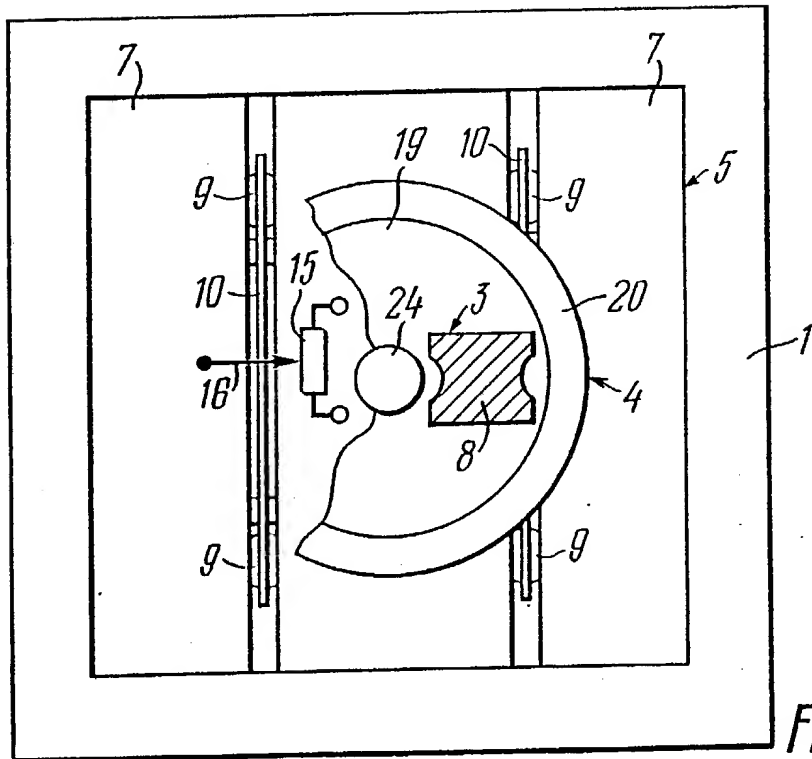


FIG. 3

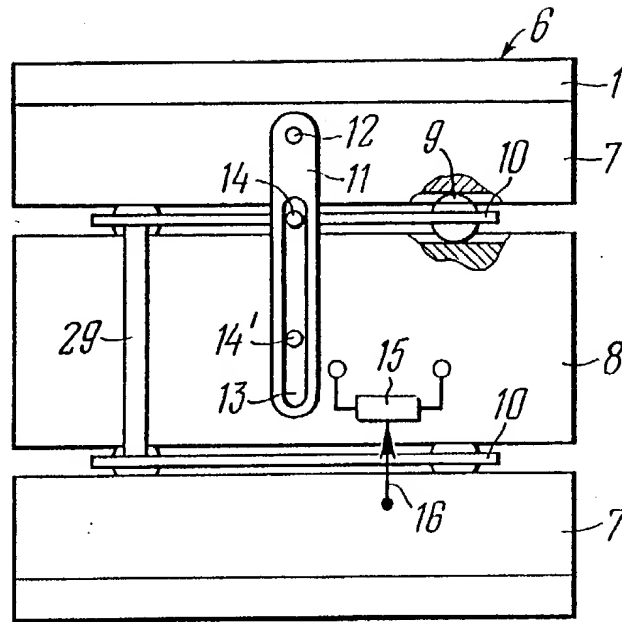


FIG. 4

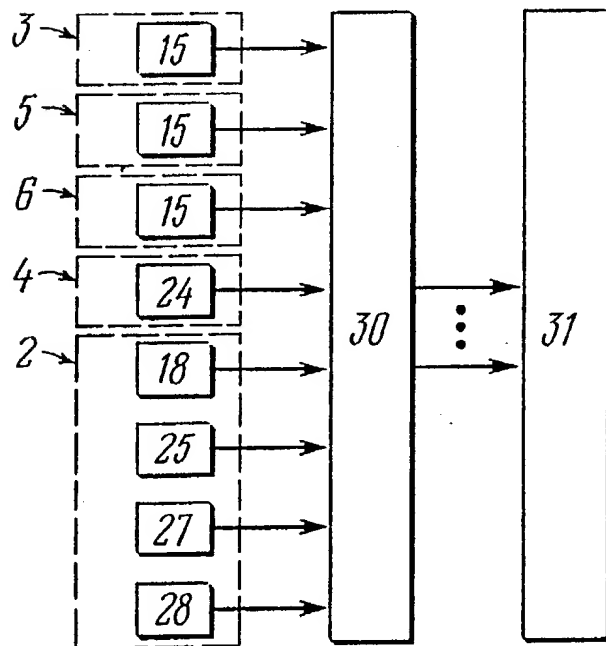


FIG. 8

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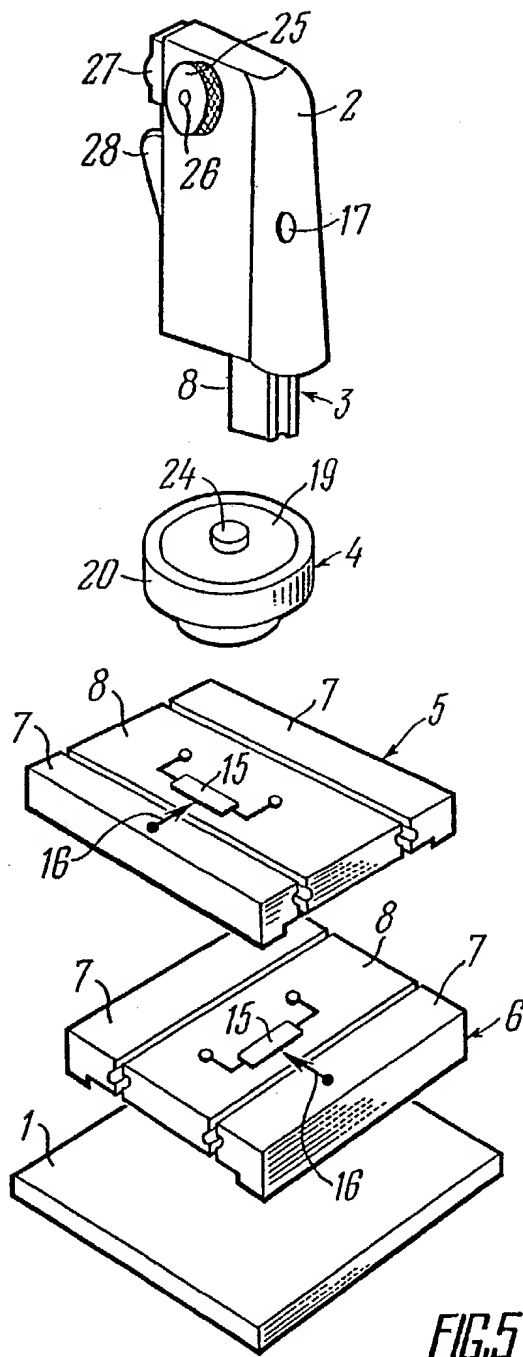
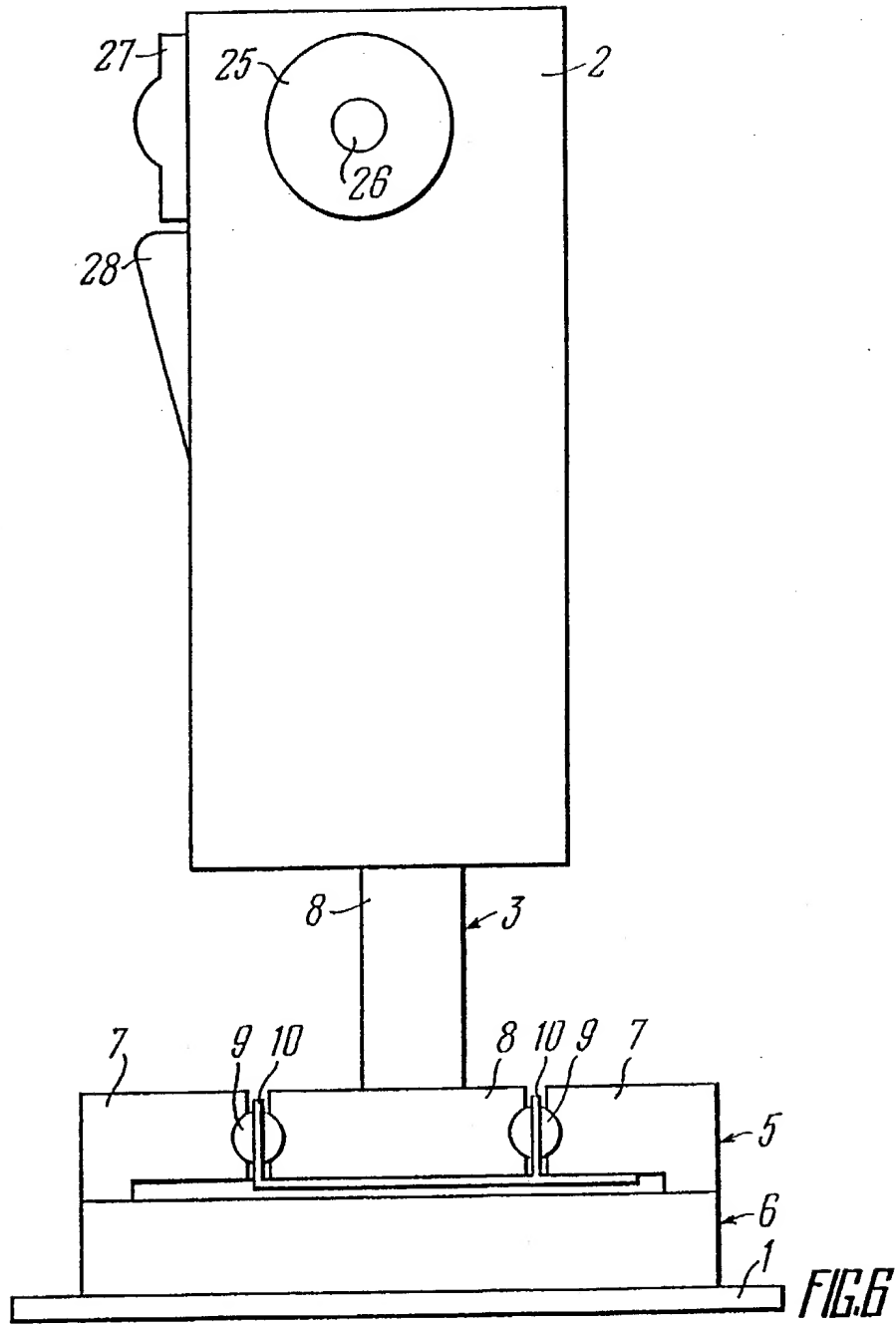
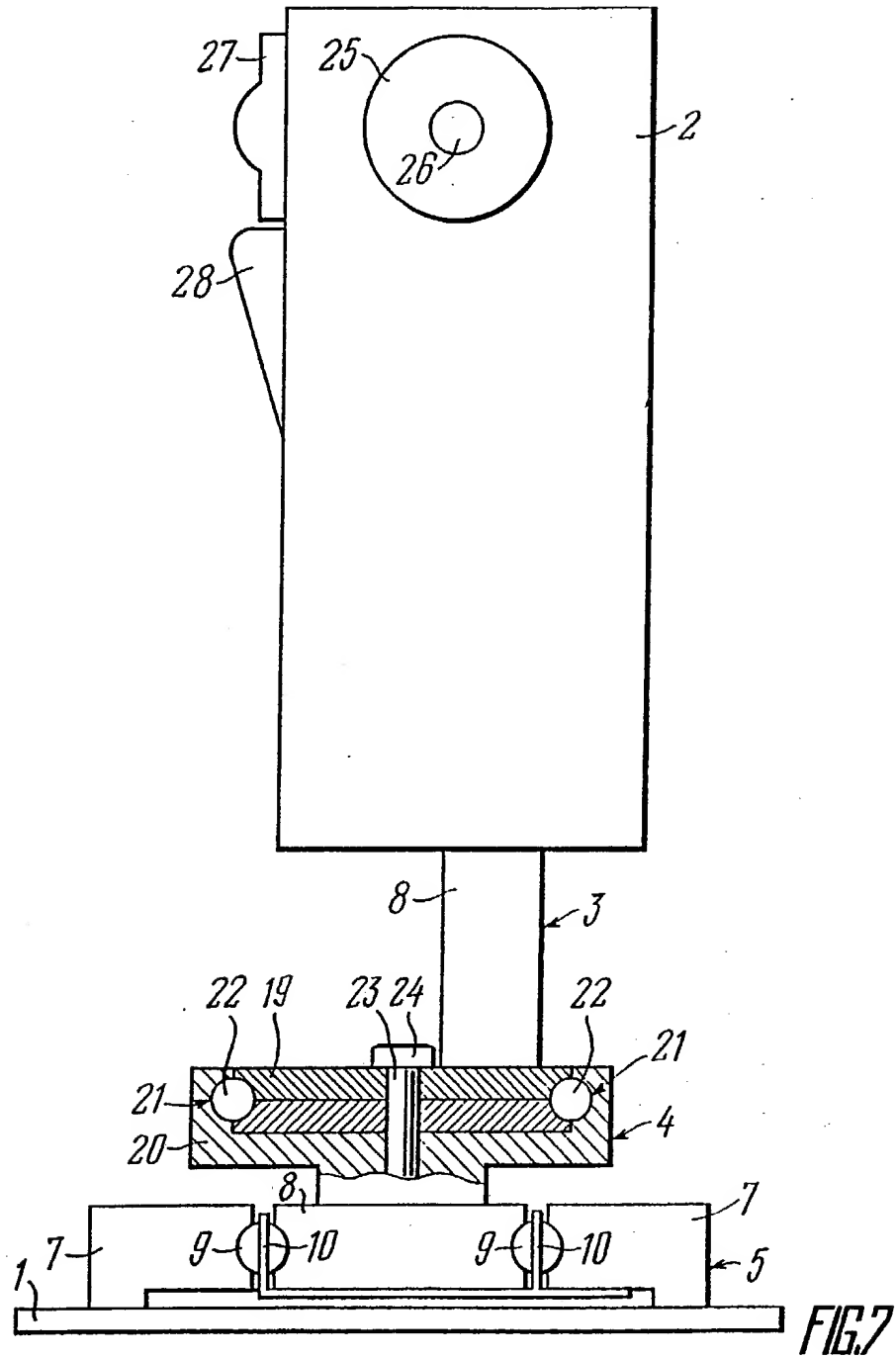


FIG. 5

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## MANIPULATOR CONTROL DEVICE

The present invention relates to control of manipulators and in particular to manipulator control devices.

The invention may be used in control systes for  
5 industrial robots, remotely operated manipulators and  
controllable moving objects, which are used in automa-  
tic lines, in a medium harmful to health. It is also  
suitable for remote control of space and underwater  
installations and objects located in extreme zones  
10 characterized by radioactive irradiation, high or low  
pressure and high or low temperature.

There is known a manipulator control device (cf.  
SU, A, 739,505) comprising a base, a mechanism for  
shaping signals enabling manipulator movement with po-  
15 sition pickups, which is connected to the base, and a  
control handle linked with the mechanism for shaping  
signals enabling manipulator movement. The mechanism  
for shaping signals enabling manipulator movement comp-  
rises two pairs of rotary arched members interconnect-  
20 ed by a telescopic rod. The position pickups are locat-  
ed on the bushing of the telescopic rod along axes of  
rotation of the rotary arched members. Each rotary arch-  
ed member is linked with an assembly adapted for fix-  
ing said arched members in a neutral position.

The foregoing control device does not provide for changes in the construction of the mechanism for shaping signals ensuring manipulator movement to suit a particular type of manipulator.

5        There is also known a manipulator control device (cf. SU, A, 561,656) comprising a base, a mechanism for shaping signals enabling manipulator movement with position pickups, which is connected to the base, and a control handle linked with the mechanism for shaping  
10 signals enabling manipulator movement. The mechanism for shaping signals enabling manipulator movement comprises three pairs of parallel elastic plates which are mutually perpendicular. The plates accommodate the position pickups.

15        The aforesaid control device does not provide for changes in the construction of the mechanism for shaping signals enabling manipulator movement when the control involves a different number of manipulator mobility degrees.

20        The invention resides in creating a manipulator control device which would allow changing the construction of a mechanism for shaping signals enabling manipulator movement with a different number of manipulator mobility degrees to be controlled whereby  
25 functional capabilities of the control device would be increased.

It is an object of the present invention to in-

crease functional capabilities of a manipulator control device.

The foregoing object is attained by that in a manipulator control device comprising a base, a mechanism for shaping signals enabling manipulator movement with position pickups, and a control handle, in which, according to the invention, the mechanism for shaping signals includes successively connected modules whose number is equal to the number of manipulator mobility degrees to be controlled, the first module being operatively connected to the control handle, while the last module is connected to the base, each module mounting its position pickup.

It is advantageous that the successively connected modules of the mechanism for shaping signals enabling manipulator movement should represent a combination of translational and rotary motion modules.

It is also advantageous that the successively connected modules of the mechanism for shaping signals enabling manipulator movement should comprise a combination of translational motion modules.

It is further advantageous that each translational motion module of said successively connected modules should include parallel guides, a carriage disposed in said guides and supported by balls installed

in separators, and a synchronizing assembly formed with a single-arm lever operatively linked with one guide, one separator and the carriage.

Desirably each rotary motion module of said successively connected modules comprises internal and external casings arranged concentrically and separated by a channel filled with balls.

It is preferable that the first module of said successively connected modules should be a translational motion module whose guides are operatively connected to the control handle, while its carriage is rigidly connected to the internal casing of the next rotary motion module whose external casing is rigidly connected to the carriage of the subsequent translational module having its guides rigidly connected to the guides of the last translational motion module whose carriage is rigidly connected to the base.

It is also preferable that the first module of said successively connected modules should be a translational motion module whose guides are operatively connected to the control handle, while its carriage is rigidly connected to the carriage of the next translational motion module having its guides rigidly connected to the guides of the last translational motion module whose carriage is rigidly connected to the base.

Advisably the first module of said successively

connected modules is a translational motion module whose guides are operatively connected to the control handle, while its carriage is rigidly connected to the internal casing of the next rotary motion module having  
5 its external casing rigidly connected to the carriage of the last translational motion module whose guides are rigidly connected to the base.

The invention makes a manipulator control device more versatile, that is, it permits controlling manipulators with a different number of mobility degrees  
10 using the same control device.

The invention will now be described further with reference to specific embodiments thereof, taken in conjunction with the accompanying drawings wherein:

15 Figure 1 is a general view of a control device with three translational motion modules and one rotary motion module according to the invention;

Figure 2 is a sectional view of Figure 1 taken at II - II according to the invention;

20 Figure 3 is a sectional view of Figure 1 taken at III - III according to the invention;

Figure 4 is a sectional view of Figure 1 taken at IV - IV according to the invention;

25 Figure 5 is a diagrammatic perspective view of the manipulator control device according to the invention;

Figure 6 is a general view of the control device

comprising three translational motion modules according to the invention;

Figure 7 is a general view of the control device comprising two translational motion modules and one  
5 rotary motion module according to the invention; and

Figure 8 is a block diagram of a manipulator control system according to the invention.

Referring to the drawings the manipulator control device forming the subject of the present invention  
10 comprises a base 1 (Figure 1), a mechanism for shaping signals enabling manipulator movement, which is connected to the base 1, and a control handle 2 linked with the mechanism for shaping signals enabling manipulator movement, said mechanism comprising successi-  
15 vely connected modules 3, 4, 5 and 6. The number of modules is equal to the number of manipulator mobility degrees to be controlled, which is four in the preferred embodiment of the invention. The module 3 is operatively connected to the handle 2, while the mo-  
20 dule 6 is linked with the base 1.

The successively connected modules of the mechanism for shaping signals enabling manipulator movement represent, for example, a combination of translational and rotary motion modules.

25 The modules 3, 5 and 6 are translational motion modules. The module 4 is a rotary motion module. The translational motion modules 3, 5 and 6 are construct-

ed in a similar manner, each module comprising two parallel guides 7, a carriage 8 disposed in the guides 7

and supported by balls 9 installed in rigidly interconnected separators 10, and a synchronizing assembly  
5 operatively connected to one guide 7, to one separator 10 and to the carriage 8. The synchronizing assembly of each module includes a single-arm lever 11, one end of which is connected to one guide 7. by means of a fastening element 12. The lever 11 has a slot 13 for  
10 connection with one separator 10 and the carriage 8 by means of pins 14 and 14<sup>1</sup>, respectively. The carriage 8 mounts a position pickup 15 whose movable contact 16 is rigidly connected with one guide 7. The pickup 15 furnishes a signal enabling translation of the  
15 manipulator. The guides 7 of the module 3 are linked with the control handle 2 in a manner allowing their rotation about axes 17, a position pickup 18 furnishing a signal enabling rotation of the manipulator being arranged along one of said axes.

20 The rotary motion module 4 comprises an internal casing 19 and an external casing 20, which are arranged concentrically and have a channel 21 therebetween, said channel being filled with balls 22. Arranged along an axis 23 of rotation of the module 4 is a  
25 position pickup 24 furnishing a signal representative of angular movements of the manipulator.

The control handle 2 is provided with a pickup 25  
furnishing a signal indicative of angular movements  
relative to an axis 26 after operation of a close-open  
switch 27 of the manipulator grip (not shown in the  
5 drawing), the control handle 2 being also fitted with a  
pickup 28 furnishing manipulator speed control sig-  
nals.

Figure 2 is a sectional view of Figure 1 taken at  
II - II. The separators 10 are interconnected by a  
10 plate 29 enabling simultaneous movement depending on  
the position of the control handle 2.

Figure 3 is a sectional view of Figure 1 taken  
at III - III.

Figure 4 is a sectional view of Figure 1 taken  
15 at IV - IV. The separators 10 are interconnected with  
the plate 29.

Figure 5 is a diagrammatic perspective view of  
the manipulator control device according to the in-  
vention.

20 There may be different combinations of modules  
in the mechanism for shaping signals enabling mani-  
pulator movement depending on manipulator mobility  
degrees.

The mechanism for shaping signals enabling mani-  
25 pulator movement may comprise, for example, transla-  
tional motion modules 3 (Figure 6), 5 and 6. With  
such an arrangement, said mechanism is suitable for



controlling a manipulator in three mutually perpendicular planes. Rotary motions of a manipulator relative to two mutually perpendicular horizontal axes are accomplished by the use of the pickups 18 (Figure 1) and 25 (Figure 6).

Furthermore, the mechanism for shaping signals enabling manipulator movement may comprise the translational motion modules 3 (Figure 7), 5 and the module 4 adapted for rotary motion relative to a vertical plane. Rotary motions relative to two mutually perpendicular horizontal axes accomplished by the use of the pickups 18 (Figure 1) and 25 (Figure 7).

Figure 8 is a block diagram of a manipulator control system.

Referring to the drawing the position pickups 15 of the translational motion modules 3, 5, 6, the position pickup 24 of the rotary motion module 4, the pickups 18, 25, 28 and the close-release switch 27 of the control handle 2 are connected to inputs of a computer 30 whose outputs are connected to inputs of manipulator drives 31.

The operator controls manipulator movements by setting the control handle 2 (Figure 1) to a desired position.

As the control handle 2 is shifted vertically, use is made of the translational motion module 3 whose guides 7 move relative to the carriage 8. The single-arm lever 11 of the synchronizing assembly connected

to the carriage 8 by means of the pin 14<sup>1</sup> rotates with respect to the fastening element 12. The lever 11 acts on the pin 14 linked with one separator 10, thus shifting it in the direction of movement of the guides 7.

5 Hense, there occurs simultaneous (synchronous) movement of the guides 7 and the separators 10 with the balls 9 relative to the carriage 8. As the guides 7 move relative to the carriage 8, the position of the movable contact 16 with respect to the pickup 15 changes.  
10 es. As a result, the magnitude of the signal derived from the pickup 15 changes. The pickup 15 furnishes a signal proportional to the displacement of the guides 7 relative to the carriage 8. The output signals of the pickup 15 are applied to one of the inputs of  
15 the computer 30 (Figure 6).

As the control handle 2 (Figure 1) is rotated relative to the vertical axis 23, the internal casing 19 of the rotary motion module 4 turns relative to the axis 23. The position pickup 24 develops signals  
20 proportional to a relative turn of the internal casing 19 with respect to the external casing 20, said signals being fed to one of the inputs of the computer 30 (Figure 8).

As the control handle 2 (Figure 1) is shifted  
25 horizontally in mutually perpendicular directions, corresponding signals will be derived from the pickups 15 (Figure 5) of the translational motion modules 5

and 6. The modules 5 and 6 operate in much the same manner as the module 3.

As the control handle 2 (Figure 1) is swung relative to the axis 17, the pickup 18 furnishes a signal proportional to a relative turn of the control handle 2 with respect to the guides 7 of the translational motion module 3, said signal being fed to one of the inputs of the computer 30 (Figure 8). When the pickup 25 (Figure 1) is rotated relative to the axis 26, it develops an output signal proportional to the angle of turn of the pickup 25 relative to the axis 26. By turning on or off the switch 27 the operator controls the closing or opening of a manipulator grip (not shown in the drawing).

Acting on the pickup 28 (Figure 1) the operator causes the generation of a signal controlling the manipulator speed, said signal being likewise applied to one of the inputs of the computer 30 (Figure 8).

The computer 30 recomputes the coordinates and generates signals controlling movements of the manipulator drives 31. The rate of change of manipulator movements is determined by the magnitude of the signal derived from the pickup 28 designed to produce signals controlling the manipulator speed.

There may be different combinations of modules in the mechanism for shaping signals enabling manipulator movement depending on a manipulator mobility degree.

These modules operate similarly to the modules shown in Figure 1. So, the proposed manipulator control device permits changing the structure of a mechanism for shaping signals enabling manipulator movement when a different number of manipulator mobility degrees is to be controlled. Signals derived from position pickups of a mechanism for shaping signals enabling manipulator movement are linear functions representative of a control handle position, a feature improving quality of control.